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## TRAINING FOR FOREIGN EXPLORATION

H. FOSTER BAIN

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# SCHOOL *of* MINES *and* METALLURGY

UNIVERSITY *of* MISSOURI

## Training for Foreign Exploration

*An Address by*

H. Foster Bain

DIRECTOR, UNITED STATES BUREAU OF MINES

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# TRAINING FOR FOREIGN EXPLORATION

H. FOSTER BAIN

Annual Commencement Address, April 29, 1921

Mining engineering occupies a borderland. In common with other branches of engineering it is an "art and science by which the mechanical properties of matter are made useful to man in structures and machines"—but with a difference. The civil engineer digs a hole to put something in it, a foundation perhaps. The mining engineer digs a hole to get something out of it, the ore. If he puts anything into the hole, timbers to support the excavation perhaps, he does it grudgingly and always with a view to the utmost economy of material. He cannot, as can his fellow professional, build with an eye to the long future. He must always face the fact that his main object is to get things out of holes and that when he has got out of a hole all that nature had put in it, neither the hole nor the plant used in the work has any further value. There is but a modicum of salvage upon which he may count. In many particulars his work shows analogies to that of a contractor, and the same logic that leads a contractor to low first cost installations is good, within reason, for the mining engineer. He does his work and moves on, and there is probably no profession calling for equal skill and learning in which the members wander more. Always they are seeking or extracting or utilizing materials forming part of the crust of the earth, and usually are doing it under conditions or with equipment that is at least suggestive of being temporary. The mining engineer must improvise, and he must be versatile. Of him it may be written as Kipling has of the marine:

> "For there isn't a job on the top o' the earth the beggar don't know nor do,
> You can leave 'im at night on a bald man's 'ead to paddle 'is own canoe:
> 'Es a sort of a blooming cosmopolouse—soldier and sailor too."

To the lore of the geologist he adds the skill of the engineer and the science of the metallurgist. Always and everywhere an eclectic, he adapts means to the end. Clearly where there are such varied duties and opportunities room for specialization exists, and this is, indeed, the fact.

Mining engineers, employing that term in the broad general sense in which it has common usage, are called upon for three sorts of work: *a*, geological; *b*, mining proper, and *c*, metallurgical. No one man may be expected to be competent in all three, and each branch is really a profession within a profession, but a man who stays long and achieves success in mining engineering must know something of all three, and young men who leave the schools, regardless of the point of the triangle at which they begin, seem in practice liable to end at either of the other. Each of the three has applications outside mining or verges over into other fields. Thus the border line between metallurgy and chemical industry is shadowy, the ties between mining engineering proper and civil engineering are many and close, and geology is a broad science which touches many fields aside from those related to ores and minable minerals. It is, however, the light that geology throws on the genesis and especially the occurrence of ores and minerals that interests the miner, and it is in finding minerals and guiding development that it is of most direct benefit to him. This work is fundamental to mining. And it is the work of the exploration engineer. It may be of interest to inquire as to the probable future demand for his services and the training necessary to qualify him for service. Since mines are wasting assets, the very life of the mining industry is dependent upon the continual finding of new mines, new ore bodies, and new reserves. When this stops mining will stop, though the death may be a lingering one. Whatever may be true as to a particular type of mining or mining in a particular locality, it must further be clear that so long as man persists on this earth he will have use and need for some portions of its crust and that, therefore, mining in some form will continue. Each individual mine, be it ever so long lived, is eventually worked out and becomes worthless and other mines must be found to take its place. The emphasis changes and minerals or metals eagerly sought by one people or one generation are less important to those who come later, sometimes because their wants are supplied from a different source. In the early settlement of the Mississippi Valley local salt supplies were so important that salt lands were generally set aside as being of particular value. Now these local supplies are of so little importance that they are generally not worked. Nevertheless the salt industry is many fold larger and more important than was contemplated by our grandfathers. The human need for salt is as great as ever, and with increasing population more salt and hence more salt mines have been needed.

As there comes to be more people in the world there will be more

need of mineral products and, disregarding the substitution of one for another, the minimum rate of increase in output for the minerals as a whole may be safely taken as that of increase of population.

There is an additional factor that lends assurance to the future of mining. As civilization spreads and industrialization becomes increasingly intensive, the per capita consumption of minerals increases. Man comes more and more to depend upon energy taken from the earth to supplement his own labor. The brilliant civilization of the Greeks was based upon slave labor. It is worth remembering that in the golden age, which the classicists so love to recall, the mines of Larium, worked by slaves, were so productive that each citizen of Athens received a dividend in place of an annual tax notice. Naturally they had time to sit around in the sunshine and talk philosophy. The people of our times will not tolerate slavery. We have found a better way in that we harness to our use the energy of falling water and of fuels and so are each served by invisible, non-consuming genie of the earth. The peoples who make the most use of earth materials and forces are the peoples who work the shortest number of hours, produce the most goods and have the most to divide among themselves. There are great differences between the peoples of various countries and centuries in this particular. Probably the civilized man, on the average, eats little if any more food than his ancestors did, but he does burn more coal and uses more metals. Even among the various peoples of the present there are differences. The Chinese use about $^1/_{20}$ ton of coal per capita per annum. Americans use approximately 6 tons, and other peoples use various amounts between. Generally speaking, the world is learning to use more and more coal and so to substitute the mechanical energy of heat for human labor. The pre-war per capita consumption of copper in the United States was 6 to 7 pounds and for France about $\frac{1}{4}$ pound. In Russia it is very much less, but nothing can be more certain than that through a term of years the peoples of other countries are going to approximate more closely to American standards of consumption. The United States is by no means the only country where modern plumbing is appreciated, and as the cult of the bathtub spreads around the world the consumption of the metals will grow. This demand can only be supplied by re-use of old metal or by making addition to the world's stock. Mineral wealth, fortunately, is not necessarily consumed in use. There is wastage but there is also salvage, and large amounts of old metal are continually returning to use, so much so that important metallurgical processes such as making open-hearth steel and cement copper are based upon supplies of scrap metal.

The existing stocks of the various metals represent accumulations of all the centuries that have gone before, though very much the larger part has been won within the last hundred years. There have been times in the past when but little was added to the stock and there have been peoples who merely captured in war and used the metals mined

by others. This was true of the Tartar dynasties in China. The peoples who ceased to mine ceased to progress in civilization and the great civilizations of the past were those in which the people laid under tribute more and more of the earth.

As yet no people are known who have accumulated a sufficient stock of metals to supply themselves by remelting and at the same time to make progress in civilization. Having regard to the many activities that lead to wastage it seems improbable that any active people will reach the stage where they will not require periodic additions to their stocks of metals. In the opinion of economists, also, no active people have yet reached a point of saturation as regards even steel, the most common of our metallic alloys. It seems, therefore, safe to assume that demand for minerals will continue to increase.

Two methods of meeting this increasing demand are known. By improvements in technology and financing it will be possible to lower the limit of metal content which separates ore from waste and so increase the reserves in known deposits or make into ore deposits what are now mere mineral segregations. This is a fruitful field and calls for application of the highest type of skill and genius in our profession. It is one in which remarkable results have been achieved. Working 1% copper ores means handling 2,000 pounds of material to recover less than 20 pounds of copper, for even the best practice involves losses. It is only possible to do this by application of excellent technology and remarkable powers of organization and financing. In producing helium from natural gas a raw material containing less than 1% is used and the technology involves incursions into low temperatures and high pressures not previously applied. on any large scale outside physical laboratories.

A second way to meet the future demand for mineral products is to discover new deposits either of types made profitable by the improvements of process and business organization just mentioned, of types long known, or of new types. Fortunately there are opportunities of finding all three, and in all this work exploration enters. The search for "porphyry coppers" has been a wide one. Beginning in the United States, it has long since spread into foreign fields. It has led men into many of the odd corners of the earth and there are regions yet to be explored. In conducting this work knowledge of the widest character is desirable. When Mr. C. G. Gunther began his search in Mediterranean countries, which has resulted in the development of an American mine of promise on the Island of Cypress, the first step was a reading of the classics. The Romans and earlier rulers of the region had sources of copper which, while small as judged by present American standards, might, it was thought, well point the way to a source for modern production. It will be recalled that the Utah, Chino, Ray, Nevada Consolidated, and other of our modern enterprises built on older small scale undertakings. Mr. Seeley Mudd, the eminent mining engineer who studied in a Missouri school and

began his professional career in a Missouri copper mine, had the vision of applying in the Mediterranean region the knowledge which had grown out of American experience. He and his associates found in Mr. Gunther an excellent, enthusiastic agent. The work began, as I have intimated, with a careful review of the classics and was followed by field studies first in North Africa and later in Asia Minor, where old mines offering promise of profit under modern methods were found. I cite this instance to enforce the observation that no knowledge comes amiss to an exploring engineer. I hope it will not be construed into an argument for making Greek and Latin required courses in mining schools, but it does show that wide learning is of real value to a mining man who proposes to do more than conduct a local and minor operation. As for Greek and Latin, mining men as well as others who can without undue sacrifice of time become acquainted with them will gain by doing so. It is well though to preserve a sense of proportion, and mere knowledge of foreign languages, ancient or modern, hardly qualifies one to assume responsibility as operator or advisor in mining. Indeed, a surprising amount of work can be done through interpreters, since to a good geologist the rocks speak direct and a competent miner or metallurgist can piece together the story of old works and furnaces from scattered remains, drawing inductions as surely as does the vertebrate paleontologist from a few bones. Get all the knowledge of modern languages that circumstances permit. Some have a facility in this which carries them far, but remember that it is but a means to an end. In the course of a recent professional trip lasting some twenty months business took me into countries and regions where eleven distinct languages or dialects were used, so distinct that for each interpreters were necessary. If I had stopped to learn each language before transacting business I would never have found time to do the work for which I was sent. Such experiences are not unusual in these modern days of wide travel. It is helpful but not necessary to know modern languages. Even when no interpreter is available a few simple words will carry you surprisingly far. It is not only that they are useful in themselves but they help to establish friendly relations. People generally take it as an effort to good understanding that you have tried to become qualified to talk to them in their own tongue, and words in any language carry an accumulation of associations which is left behind in translating. You must, however, depend largely on yourself. Use your eyes and your feet. Get out into the field and observe. Leave, if you must, puzzling questions as to labor supply, laws and regulations until you can get a competent interpreter, but for the facts as to character and extent of the deposit you wish to see depend on your own powers and energy.

I am speaking now of language study as a means. Language and the whole group of so-called cultural studies have another use, one not to be overlooked. If you purpose to be an exploration engineer you will spend much time away from home often under most uncon-

genial surroundings. I once asked a young man returning from an outpost in West Africa what he considered most important for one to have before going into such work. I was a bit surprised when he answered, "a college education." Experience had taught him that a well stored mind is the best companion, not only in solitude, but of a man surrounded by primitive and brutalizing conditions to which he does not wish to succumb. It has been my experience to note young men of good antecedents who have dissipated and become mere brutes when left alone among savage or nearly savage people for lack of mental reserves. Mental balance and mental resources are of peculiar value as stabilizers under such conditions.

Search for "porphyry coppers" and similar deposits will almost certainly carry you into regions of ancient mining. It is well to be on your guard neither to underestimate or overestimate the older civilizations. The ancient miners did many things well. They are apt to have exhausted the bonanzas down to water level, and high grade ore in old workings is rare. Their costs were low since the mines were operated mainly by slave labor. It does not follow that because others worked a mine for centuries or even because it yielded considerable aggregate of metal it can profitably be exploited under modern conditions. With primitive tools the ancients accomplished wonders. There is, however, one assumption that it is usually safe to make—they did not work far below permanent underground water level, since no amount of human labor quite accomplishes the work of modern pumps.

Just as we must remember that price relations of labor and metal were in ancient times very different from those of today, so we should bear in mind that in the past people were satisfied with amounts of metal that would be considered insignificant now. Mr. E. C. Eckel has pointed out that at the time of the discovery of America the total amount of gold accumulated in Europe in all forms was worth less than $100,000,000, and that up to the American Revolution the iron made annually in this country was but 15,000 to 25,000 tons. Even at that it was equal to the output of England. Many deposits which would satisfy such demands are of no importance whatever under modern conditions of business and technology. Whole groups, therefore, of ancient workings may be passed in review quickly once you are satisfied as to their type and average extent.

Finding deposits suitable for large mining exterprises is, however, not the whole of the work of an exploring engineer. He may be employed to look up sources of some mineral which does not occur in large bodies, such as tungsten or vanadium. In such cases little bodies must be regarded as jealously as are large ones of cheaper metals. A due sense of proportion is of high value to him and an intimate knowledge of the mode of occurrence of the mineral he is seeking to find is a first essential. Placer gold has a natural habitat and there are characteristic differences in types of deposits which may be correlated

with the character of the country rocks, the extent of their metamorphism, the presence or absence of intrusives, the character of the latter, the physiographic history of the region and similar geological features. Much is known now of metallogenic provinces and something of paleogeography. All this and more is useful to one engaged in finding ore.

In estimating the value of professional knowledge necessary for success as an exploring mining engineer, I would, therefore, place a good working knowledge of geology first. This should extend not only to the technic but to the sources of information and to current knowledge of the geology of the region to be explored. A metallurgist or a mining engineer engaged in operation of properties does not need so comprehensive an understanding of geology. It is sufficient if he knows the general scope of the science and the particular ways it may be applied to problems he must face. It is by no means necessary that he should be versed in its technic, since there will always be within reach men skilled in the art who may be called to his assistance. What he should know is when a geologist can be helpful and how to use him in his work. It would be better for such men to concentrate their time and energy upon acquiring a complete mastery of their own work rather than an amateur and probably misleading knowledge of geology.

In the case of the exploring engineer the case is different. His prime function is to find ores, and to do this he must know ore bodies and the laws which govern their occurrence. These laws are imperfectly understood, much regarding them remains to be learned and to resolve these doubts calls for the most complete knowledge obtainable concerning the principles of geology, the history of the earth, and the technic of making geological studies. It is therefore important that the exploring engineer should be first of all a well trained geologist, one capable of observing, recording, weighing and judging the numerous facts of which account must be taken in making his determinations.

Much observation has convinced me, though as to this there are differences of opinion, that it is better if he learn his geology first as a scientific study. There is a high value in the detached point of view of the man who loves science for its own sake and counts truth as most important. Men so trained have usually more vision. They have a wider knowledge of the literature of the subject and of the work of others. They are less eager to accumulate only the facts of immediate importance and so have more facts and more theory upon which to fall back when in difficulty. They do their work better because they look over the whole problem first. Not infrequently they make large savings by eliminating unprofitable work through preliminary study of literature. For all these reasons I would recommend the man who purposes to devote his time to exploration to study geology first and to study it as though he expected to be a professional geologist.

This, however, is not alone enough. It requires but little knowledge of the field to recognize that many serious mistakes have been

made through relying on the advice of geologists. For this particular work of finding ore is needed more than the usual equipment of a good geologist. The latter is rarely versed in economics, and this is almost equally essential. Too many geologists have no adequate understanding of the relative importance of things from the miner's point of view. Not being trained in assuming financial responsibility for mistakes, they are cheerfully optimistic when to be unduly so invites failure. Their first tendency is to general advice, and all too promptly they will sketch out plans for development that call for millions when perhaps thousands alone are available. The geologist therefore needs further training before he is properly prepared to advise regarding mining development. As a geologist he is what one may call semi-finished material though, I would have you understand, most excellent material for further manufacture.

When the prospective exploring engineer has completed his scientific studies he needs help and criticism from his fellows, the mining engineer and the metallurgist. It is not necessary that he should become equally learned in their branches of the profession, but it is essential that he have a clear conception of the scope, character, and limitations of their work. It is his business to find the ore which the mining engineer shall mine and the metallurgist treat. Clearly no one will be profited by his finding and mapping metalliferous segregations which cannot be mined or are not amenable to treatment. It may be highly interesting and of great scientific import to map such bodies of mineral, but that is the function, among others, of the geologists of official surveys. The exploration engineer must work to find something out of which a profit may be made or he has not found ore. Clearly he must know, at least in general terms, the limits of cost which separate ore from rock, and he must have some well defined ideas of the technical difficulties to be overcome in mining each particular deposit and of the methods likely to be applied. It is not necessary that he should be able to make the application. That calls for skill of another character, but he must know, and know surely, that some one of several methods, perhaps, may be applied and must be able to approximate the cost. It is useless to find and drill placer ground where the boulders are too large and numerous, or the bottom too hard or pinnacled, to permit dredging, while the supply of water, of storage space, or the grade prevents hydraulicking or sluicing. There are dry placers, it is true, but if the exploration engineer finds conditions so unfavorable he would do well to defer drilling until after taking expert advice as to methods and costs of dry washing. It is also useless to spend money on a careful examination of a placer property unless there is reason to anticipate that the gravel will yield as much or more than the cost of working elsewhere under similar conditions. To determine this, one must know what constitutes similar conditions and what usual and unusual costs are. It is no part of the ordinary training of the geologist to accumulate such data, and if he is to suc-

ceed in exploration he must draw on the experience of the engineer for it either by serving an apprenticeship under him or having always a competent engineer as an associate. The latter is not always feasible, and it is greatly to the benefit of his future if the geologist will serve for a time as helper to a good engineer in operating or examination work. It will help him to get into the habit of quantitative thinking and he will learn much of the law of averages. For one thing, engineering methods of sampling are on a much sounder basis than are those of the geologist. It is one of the minor tragedies of scientific work that so much high thinking is done over non-representative samples. Geologists generally have the same naive confidence as has the prospector and promoter in their ability to take a "grab" sample which will be representative, and this is a common source of error and disappointment.

Having said so much in disparagement of the profession which I have long loved, let me add that in the study of placers there is no knowledge that entirely compensates for lack of clear conceptions of geologic history and skill in geologic interpretation. Placers are the products of rivers or beach action. Their accumulation is an incident in river, lake or marine history and may be closely correlated with the physiographic history of a region. There are definite places at which they may be expected to occur and others at which it is useless to seek them. Frequently they relate back to ancient rivers and to physiographic stages in the past whose marks, obscured by later changes, may be picked up only by the skilled eye, and of which the evidence may be correlated only by an active, well trained brain. To indicate the need of supplementary training and experience is not to discredit what is sound and useful in that already given to geologists. While I have drawn my illustration from the field of placer mining, a similar argument may be made in the case of lode mining, where structure, secondary enrichment, and other phases of geology are equally important, but where also it is necessary to know in outline of mining methods, especially of the critical limits, both technical and financial, of their application. The situation is the same in exploration for gas and oil except that petroleum technology, being newer, is not as yet well formulated and the financial limits are more elastic. The rewards of success in oil and gas production are so much larger in proportion to the immediate investment, and the returns are so much more prompt, that it is not possible to estimate probable costs as closely as in other forms of mining.

Consideration of costs leads one into the larger field of economics, a popular branch of learning just at present. Aside, however, from this new general interest in what was once called "the dismal science," and belief in its applicability to present day problems, there are permanent reasons for the exploring engineer acquiring more than a slight acquaintence with economics.

Minerals are the raw materials on which are based numerous in-

dustries and the conditions which limit their use are the same in many particulars as are those which unduly aid industry in a given region. Security of title, stability of government, availability of labor, adequacy of financial support, these are all matters to be considered in exploration and they are also matters studied by economists. Here again the exploring engineer may to his advantage draw on a fellow professional for methods and data. His own training prepares him to judge as to the material. Matters concerniug men and money are, however, equally important since the test of his results is whether he has found something which may be produced with reasonable expectation of profit. The subject is too large for discussion here. I may merely mention a few items by way of illustration.

One of the assumptions too commonly made is that low wages necessarily means cheap production. This may or may not be true. It is largely a matter of efficiency. If it requires, as it sometimes does, six miners of one race to do the work of one of another, it must be clear that paying wages in the ratio of one to six does not lower costs. Not only that, but the final cost of production with such "cheap" labor will be higher because of the larger number of working faces necessary in the mine, greater amount of equipment, the extra supervision and housing, the higher accident ratio and other matters, all of which enter into the final cost. On the contrary, one must not conclude that raising wages cheapens production. It only does so when increased efficiency results from the added desire on the part of the men to hold their jobs, or when it enables a particular employer to attract the better men from others. Generally added efficiency in labor is purchased at an increased cost per unit, just as the added speed of a fast steamer calls for more coal per mile than when driving at a slower rate. It is also to be remembered that there are natural inequalities in efficiency and in the economical rate of speed of work as between men. These can only be changed slowly. Another factor to be constantly kept in mind by the engineer is that one of the costs of a new enterprise is that of attracting labor to it from existing industries. It may usually be safely assumed that the people of any district are already employed. If they do not work they generally starve. What they are doing may seem relatively unimportant to the visitor but it assumes another aspect to them. It is necessary either to import men already accustomed to the industry, usually at material expense, or to tempt workers out of some other line into the new one and then to train them to it. This requires both time and money. The importance of the time factor arises from its effect on the present value of proposed investment. To illustrate: deferring the initial returns for two years decreases by 14% the present value of a series of dividends running through 20 years at 8%, assuming accumulations at 3%. The actual result varies with the assumption of time and rate, but the essential fact is that mere delay is expensive. When this delay is coupled with upkeep charges it is even more serious. This whole

matter of the possible and probable rate of and continuity of production is one of first importance in determining the availability or value of any mine or prospect. Into it enters also the various questions of market. I have already indicated my reasons for believing that, whatever may be the depressing facts of the immediate present, we may safely assume a continued demand for metals. This demand will, however, vary from time to time both for the group as a whole, such variations being due to general causes outside the industry itself, and also as relates to each metal. It is necessary to study problems such as expansion of use, substitution, periodic demand, and similar matters far aside from ordinary class room instruction. As regards a particular enterprise, it is necessary in fixing capitalization to make assumptions not only as to the probable average price of output during the life time of the investment but also the maximum and minimum to be assumed, the probable period of duration of each, and if, as is occasionally true, some guess can be made as to the impending swing of the pendulum, it will be of great assistance. A property is financed on the basis of average returns through an expected life determined by consideration of numerous factors. A company in which capital is so adjusted to income may nonetheless fail if not prepared to withstand a temporary period of low prices, while if high prices may be safely assumed in the near future it is possible to finance the enterprise from earnings to a considerable extent. There is one general rule, the old one that a "bird in hand is worth two in bush." This is sound not only because of the risk attached to the question of acquiring the two theoretically in the bush but because the one in hand, if a good hen, may lay eggs through the waiting period. The dollar of today is worth more, normally, than the dollar which is to be paid some years later because it may earn for you interest meanwhile. This principle of the greater value of quick returns when astutely used is a great help in bargaining.

It happens that there are many minerals that are only of important value when properly related to others. Iron ore, coking coal and limestone form a trinity. Nothing is of less value than a large deposit of pure iron ore where it cannot be used. The value of iron ore is less a matter of the extent and composition of the deposit than the assembly cost of raw materials at a suitable point for making pig iron and steel. Such matters seem, possibly, far from the province of the exploring engineer but all around the world are wrecks of business enterprises where money was spent to find and develop raw materials without adequate study of competition and market conditions. The exploring engineer who disregards such problems limits his usefulness and the rewards that he may expect.

Just as any engineer starting for a far country carries in addition to instruments, food, and engineering supplies, a personal kit, so there are accomplishments that are as desirable if not necessary to the exploring engineer as his knowledge of mathematics and geology. He

must know how to keep himself and his men in good health or his expedition will fail. He is the scout of industry and often the pioneer of civilization. When he goes into the wilds the health risk is often the greatest personal danger faced. Even when he goes to older settled countries the conditions of life differ from those in his own home and care is necesssary. With care it is possible to live and work in almost any country. It is now known that where it is worth while to do so, even tropical jungle lands may be made safe and sanitary. To do this involves heavy expenditure not warranted in exploration, so that the pioneers assume risks not necessarily met by the operating forces that come later. The exploring engineer would do well to look carefully to his own physical condition and watch closely the food, drink, and habits of his whole party. Learn and enforce proper rules as to camp sanitation. One careless man may wreck an expedition or cause long and expensive delays. It is generally true that the most suitable food is the food of the country but the exceptions are numerous and the cost of a mistake serious. Until the facts in each instance are established it is a justifiable expense to use imported foods. Proper cooking will render foods otherwise dangerous safe, and moderation in eating strange dishes is a wise precaution. The American habit of drinking raw water is one to be indulged with discretion in regions of older civilizations, but safe water is easily obtained by boiling. It is worth while to pay attention to details such as these which seem small to those accustomed only to our own ways of living. A knowledge of the methods of first aid and a few medicines is of great value. It is not necessary to go as far as Doc Miliken who, as you may remember, would "take that bracket saw and the mild chloride and his hypodermic, and treat anything from yellow fever to a personal friend," but a little knowledge of simple medicines will ease your way greatly in strange countries. Learn to ride, to shoot, to swim, and to handle a small boat. I need hardly admonish a young American these days to learn to run a motor car, but the accomplishments common in the older days of country and village life are becoming rare. It is not always possible to ride up to a prospect in a Pullman or even in a Ford. In the nature of things, the finding of new mines will take one into countries where only other than mining industries have been developed, and in practice that means going into regions of country and village life. At times it means rolling back the centuries and living for awhile in the medieval ages. In such places one must know about horses and mules—their habits, preferences, food, simple ailments, and capacities for work. One may, too, be called upon to use a gun, though far more probably to afford the party fresh meat than as a means of protection. To handle a boat or to swim may be a necessity at any time, though it must be admitted that in any country where small boats are used native boatmen are likely to be numerous and skillful. Skill in any of the forms of what we now call sport may well prove of first importance in an emergency and will always prove at

once a means of relaxation and of establishing relations with strangers regardless of race and language. The latter is a matter of no small importance in work when the good will of the whole party and of the people of the country traversed is so important.

Lastly, I would urge that to be successful one should have something of the spirit of adventure. Unless new scenes and new faces appeal to you, unless you find joy in the long days in saddle or afoot, unless the cheer of the camp fire means more to you than the clank of the steam radiator, unless to you coffee does not lose its fine flavor when served from a tin cup, unless you can sleep between blankets and not think of their scratching, do not undertake exploration. If you must have a napkin and morning paper at breakfast, if you can not write save at a well equipped desk, if you are not happy except with your family and intimate friends, if you must needs see the movies before you can go to bed at night, you will be wise to find a routine job at home. But to those who have a venturing nature adventures come, and if you are one of the elect who feel the spell of the Yukon, or the lure of the little voices, then go

"Adventuring! Adventuring! And oh, the sights to see
And little fires along the trail that wink at you and me,
Till the last adventure calls us from the old, the vain desires,
To a way that's still untrodden, though aglow with little fires,
Where no wanderer grows weary and a man is free to roam,
Or hang his hat upon a star and call the planet home."

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Vol. 1, No. 1, Dec., 1908. The Human Side of a Mining Engineer's Life. Edmund B. Kirby. (Commencement address, June 10, 1908.)

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